

## REMARKS/ARGUMENTS

With the entry of the present amendments, Claims 1-17, 34 and 35 are pending in this application. Claim 9 has been amended. Support for the amendments to Claim 9 may be found, for example, in Claim 1 as originally presented and in paragraph 0087. New Claims 34 and 35 have been added. Support for the new claims may be found, for example, in claims 2 and 15 as originally presented.

**I. Rejection of Claims as Unpatentable Over U.S. Patent Application Publication No. 2002/0110932 in view of U.S. Patent Application Publication No. 2002/0128234 and U.S. Patent No. 4,822,681.**

Claims 1-8, 13 and 14 stand rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent Application Publication No. 2002/0110932 filed by Wagner et al. ("Wagner") in view of U.S. Patent Application Publication No. 2002/0128234 filed by Hubbell et al. ("Hubbell") and U.S. Patent No. 4,822,681 issued to Schössler et al. ("Schössler"). Applicants respectfully traverse.

Independent Claim 1 recites a two-step method for forming a functionalized surface that utilizes plasma and gas-phase reactants. This method differs dramatically from the conventional solution-based reaction mechanisms described in the prior art. The first step of the method involves the formation of hydroxyl groups on an oxide surface by exposing the surface to a plasma. The second step involves reacting the epoxy groups on a gas-phase epoxy-functional molecule with the surface hydroxyl groups *in situ* in the absence of plasma to provide epoxy-terminated, surface-bound spacer chains. As defined in the specification in paragraph 0046, carrying out the second step *in situ* means that the hydroxyl groups are not exposed to the atmosphere prior to reaction with the gas-phase molecules.

Notably, the Examiner has not identified a single prior art reference disclosing a gas-phase reaction between an epoxy group on an epoxy-functional molecule and a surface-bound hydroxyl group. The absence of such an article reflects the fact that the conventional method of reacting epoxy-functional molecules and hydroxyl groups is to conduct the reaction in solution with acid, base or metal catalysts. This point is discussed in detail in Applicants' previous response filed on April 29, 2008. (The reader is referred back to that response for a more detailed presentation of that discussion.)

The Examiner has attempted to use a vague statement in Schössler regarding gas-phase reactions of silane functionalities on organosilanes with hydroxyl groups to support the sweeping and general conclusions that it is possible and desirable to replace all solution-phase reactions with gas-phase reactions, regardless of the particular reactive groups involved. As one of ordinary skill in the art would recognize, that is not true.

The only statement made is Schössler regarding the desirability of reacting organosilanes and hydroxyl functionalities reads as follows:

"It is particularly advantageous to effect the activation in gaseous phase through employment of aerosols or by means of underpressure." (Col. 4, lines 44-47.)

Although, Schössler does not specify any particular advantage, the Examiner has interpreted this phrase to suggest a cost advantage to the use of a gas-phase reaction. (Office Action, p. 8, 1<sup>st</sup> partial paragraph.)

Regardless of the nature of the advantage being referred to in Schössler, there is nothing in Schössler to suggest that the advantage can be generalized to chemical systems other than organosilanes. Therefore, Schössler provides no reason to carry out a reaction between a gas-phase epoxy-functional group and a hydroxyl group. As one of ordinary skill in the art would understand, the question of whether to effect activation in the solution phase or in the gas-phase would depend on the relative activation energies of the reaction in those phases. As noted above, reactions of epoxy-functional groups and hydroxyl groups are conventionally carried out in the solution phase in the presence of a catalyst. The effect of converting the conventional reaction into an *in situ* gas-phase reaction would eliminate the catalysts of the solution phase, thereby increasing the activation energy and hindering the reaction. Thus, conventional wisdom actually suggests that a gas-phase reaction should not be used.

The invention recited in Claim 1 contravenes conventional wisdom and is based on the inventors' surprising discovery that the reaction between an epoxy-group on a gas-phase epoxy-functional molecule and a surface bound hydroxyl group can be carried out effectively when the surface is not exposed to the atmosphere after the plasma-induced formation of surface-bound hydroxyl groups. Proceeding contrary to accepted wisdom in the art is evidence of nonobviousness. (M.P.E.P. § 2145 X.D.3.) Therefore, Applicants respectfully

submit that the combination of Wagner, Hubbell and Schössler fails to provide a *prima facie* case of obviousness and request that the rejection of these claims be withdrawn.

Applicants further submit that the Ecological Information in the Material Safety Data Sheet (MSDS) for epichlorohydrin referenced by the Examiner (Office Action, p. 26, 2<sup>nd</sup> paragraph) does not suggest that solution-phase reactions between epichlorohydrin molecules and surface-bound hydroxyl groups should be replaced by gas-phase reactions. The MSDS states, "[w]hen released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl *radicals*." (Emphasis added.) Surface-bound hydroxyl groups are not hydroxyl radicals. Unlike surface-bound hydroxyl groups, hydroxyl radicals have an unpaired electron which makes them extremely reactive. Therefore, the fact that hydroxyl *radicals* in the air react with epichlorohydrin does not suggest replacing conventional solution-phase reactions between epichlorohydrin molecules and surface-bound hydroxyl *groups* with gas-phase reactions.

Finally, Applicants submit that even if Schössler provided a reason to carry out the reaction of an epoxy group on a gas-phase epoxy-functional molecule with a surface-bound hydroxyl group, the combined teachings of the references cited by the Examiner are still insufficient to render Claim 1 obvious because they do not suggest carrying out the reaction *in situ* (i.e., without exposing the hydroxyl groups to the atmosphere). For this additional reason Applicants submit that the Examiner has failed to establish a *prima facie* case of obviousness and respectfully request that the rejection of Claims 1-8, 13 and 14 be withdrawn.

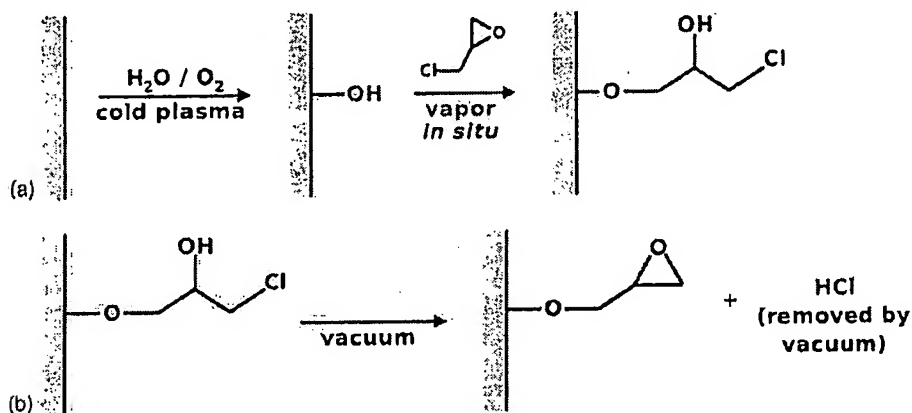
## II. Rejection of Claims as Unpatentable Over Wagner in View of Hubbell and Schössler and Further in View of PCT Application Publication No. WO 01/83826.

Claims 9 and 10 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Wagner in view of Hubbell and Schössler and further in view of PCT Application Publication No. WO 01/83826 filed by Laibinis et al. ("Laibinis"). Applicants respectfully traverse.

Like Claim 1, Claim 9 recites a method for forming a functionalized surface that involves the formation of hydroxyl groups on an oxide surface by exposing the surface to a plasma and reacting the epoxy groups on a gas-phase epoxy-functional molecule (specifically, an epichlorohydrin) with the surface hydroxyl groups *in situ* in the absence of plasma. For the reasons discussed in Section I, above, the combined teachings of Wagner,

Hubbell and Schössler fail to render such a method obvious. Laibinis fails to cure the deficiencies of Wagner, Hubbell and Schössler. Therefore, for at least the reasons discussed in Section I, above, Applicants request that the rejection of Claims 9 and 10 be withdrawn.

More specifically, Claim 9 as amended, recites a method of treating a surface of a substrate that includes forming hydroxyl groups on an oxide surface by exposing the oxide surface to a plasma; reacting epoxy groups on epihalohydrin molecules with the surface hydroxyl groups *in situ* in the absence of plasma to provide a functionalized surface; and exposing the functionalized surface to vacuum *in situ* to provide epoxy-terminated, surface-bound spacer chains. In this method, the epoxy-group on the epihalohydrin initially reacts with the surface-bound hydroxyl groups to form a hydroxyl- and Cl-functionalized surface. In the subsequent vacuum step, HCl is removed and the epoxide ring is re-formed to provide an epoxy-terminated, surface-bound spacer chain according to the following reaction mechanism:



Neither the general teachings nor the specific examples in the cited prior art references provide any reason to expose the functionalized surfaces described therein to vacuum *in situ* (i.e., without first exposing the surface to the atmosphere) subsequent to a reaction between surface-bound hydroxyl groups and epoxy-functional molecules. Therefore, the combined teachings of Wagner, Hubbell, Schössler and Laibinis fail to establish a *prima facie* case of obviousness. For this additional reason, Applicants respectfully request that the rejection of Claims 9 and 10 be withdrawn.

**III. Rejection of Claims as Unpatentable Over Wagner in View of Hubbell and Schössler and Further in View of PCT Application Publication No. WO 01/96452.**

Claims 11 and 12 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Wagner in view of Hubbell and Schössler and further in view of PCT Application Publication No. WO 01/96452 filed by Devoe et al. ("Devoe"). Applicants respectfully traverse.

Claims 11 and 12 depend from Claim 1. For the reasons discussed in Section I, above, the combined teachings of Wagner, Hubbell and Schössler fail to render Claim 1 obvious. Devoe fails to cure the deficiencies of Wagner, Hubbell and Schössler. Therefore, for at least the reasons discussed in Section I, above, Applicants request that the rejection of Claims 11 and 12 be withdrawn.

**IV. Rejection of Claims as Unpatentable Over Wagner in View of Hubbell and Schössler and Further in View of U.S. Patent Application Publication No. 2003/0113478.**

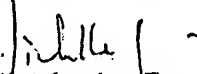
Claims 15-17 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Wagner in view of Hubbell and Schössler and further in view of U.S. Patent Application Publication No. 2002/0113478 filed by Dang et al. ("Dang"). Applicants respectfully traverse.

Claims 15-17 depend from Claim 1. For the reasons discussed in Section I, above, the combined teachings of Wagner, Hubbell and Schössler fail to render Claim 1 obvious. Dang fails to cure the deficiencies of Wagner, Hubbell and Schössler. Therefore, for at least the reasons discussed in Section I, above, Applicants request that the rejection of Claims 15-17 be withdrawn.

The Applicants believe that the pending claims are now in condition for allowance. The Examiner is invited to contact the undersigned should further issues remain. Otherwise, speedy and favorable consideration is respectfully requested. The Director is authorized to charge Deposit Account No. 23-2053 for the fees associated with a two-month extension, which the Applicants hereby request, and is hereby authorized to charge any fees required for the filing or credit any overpayment. Any required petition should be considered provisionally made.

Respectfully submitted,

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